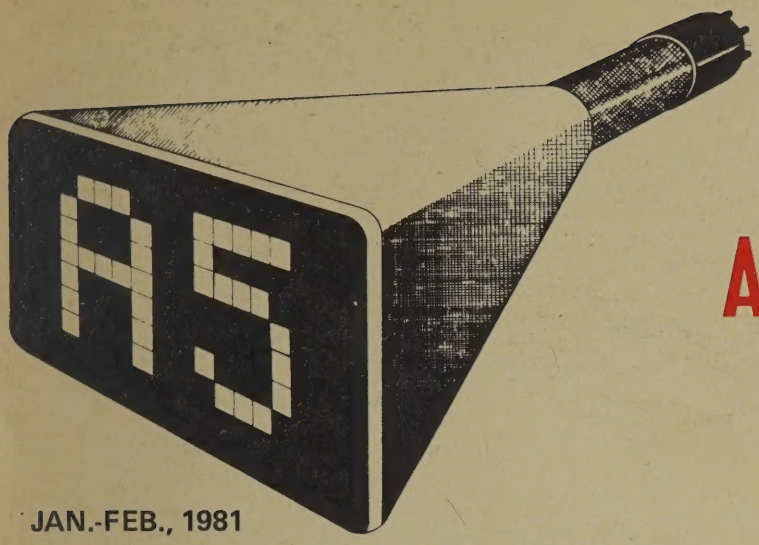

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JAN.-FEB., 1981

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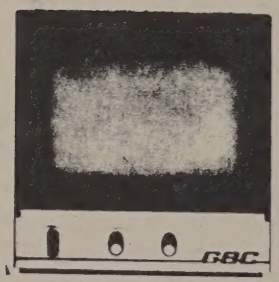

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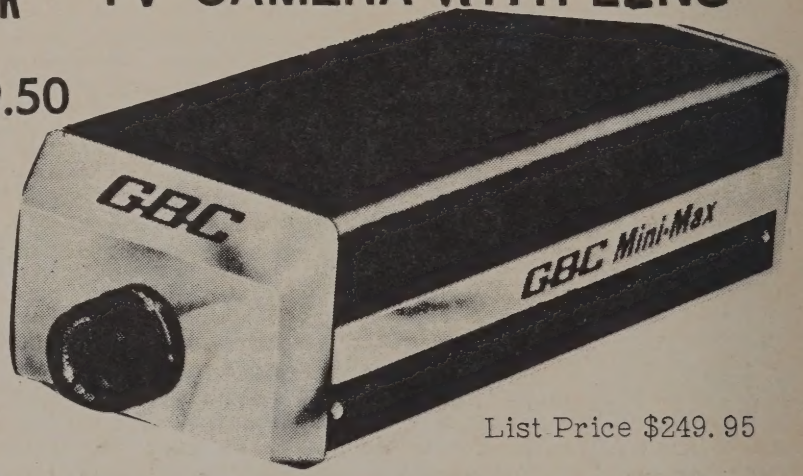

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Amateur Television Magazine

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NEWS

The big news this issue has to be the first public announcement of original research into a system to transmit TV pictures by an entirely new means, with bandwidth reduction and digital techniques being used together to provide a substantial gain in overall data rate and picture rate. The research was done by Henry KB9FO in a period from 1976 to 1980. Actual tests were made "in house" since such transmissions as described in the article are not legal "over the air" and the legal hassel to gain permission for such a radical procedure given the current structure of the FCC was assumed insurmountable. Now that the FCC has finally opened the door a crack to experimental signals, upon application for STA, etc, the authors circumstances no longer can support the research effort, and heis left to allow others to apply for and continue with the project. Therefore, now that the FCC has stated that they will accept petitions to use spread spectrum and similar techniques, the material on the theory and basis of the new TV system are presented so that anyone, anywhere may apply for over the air tests of a working system. It is hoped that someone who has the time and energy to devote to polishing the idea will pick up the challenge and continue the work. Family and career changes by Henry preclude his further involvement in the project. Lab tests using the contour signal, and monochrome video proved reasonably successful. Color signals would have been tried had a color camera been available during the research, but alas, low spendable income and high prices of color cameras precluded that. However, the theory should hold for color as well as monochrome as detailed in the article.

The actual transmission could be in seriel form, or by conversion of the data stream into a parallel data system, simultanous transmission of various data items could be transmitted simultanously. It is also possible to convert the real time contour signal, which is sent simply as a series of stop commands, it could be refined and digitized to provide a complete digital siganl.

The JPL pix of the saturn fly-by were to say the least spectacular. The scientific discoveries made in the few days dwarf the years of earth bound efforts. The discovery of active geological actions, as well as the now commonplace "rings" which seem to be on virtually every outer planet, are true wonders. Our imaginations were too earth bound, obviously, thus our suprise at the discoveries.

Speaking of imagination, you will also find a crystal ball page in this issue. It is a peek into the future of communications 20 years from today. The technology to do any if not all of the predictions is here now. And more! It is possible for instance, to measure every individual in so many ways, via computer data readouts, that what we will really experience is a serious problem with our personal security. The cable companies can tell what you watch on TV. If you watch the X movie or if you watch a religous program, it can be noted and recorded, and possibly held against you later in life. (What sort of a person watches XXX movies when Rex Humbard is on TV?) should someone find it in their beneift to do so. Your money is watched by a bank of computers from which every detail of your financial life habits can be gleaned. Do you pay your bills? Do you pay on time? Do you give to charities? the church? government officials? How much do you make per year? How buch booze do you buy? Do you save any? What clothes do you wear, how often do you see a doctor, dentist, gamble? All this and more, much more, even more personal, data is being collected on all of us right now. There is no government regulation on the collection, storage, destruction, manipulation or use of this data. We are about to lose our constitutional rights to privacy because of the information age we have entered. It is presently possible to obtain from Insurance companies, banks, schools, government files, police records, public files and other agencies which deal in computerized records, a complete document, hundreds of pages long which will cover your entire life. Big brother is a computer, and computers by the year 2000 will control 99% of our lives. Supporting a second wife? The computers will know it, and anyone will be able to find out. Date your secretary? Likewise. The big question to be answered in the future will not be related to technology, it will be related to information and the communication of that information. Who will protect your rights as an individual against the unscrupulous use of the computer data banks ammassed about YOU? With a TRS-80 and a few code words for access, anyone can insert bogus data into your computer file and you would not know it until you one day discovered that you had been ruined by such information. The real question will be SECUTIRY and PRIVILAGE. Who has access and CONTROL of the computer files, and who will have the right to examine the records and correct the errors and prevent abuses.

A NEW TELEVISION SYSTEM. And some thoughts about current systems.

To understand the information in the following article, it is probably necessary to lay a little foundation of basic information about televison in general...First, the system we use has been developed from mechanical systems, into electro-mechanical systems. You may not think of your home TV as having much mechanics except for the rotation of a few knobs, or the pushing of a few buttons. But in fact the actual system used to generate the displayed image is highly mechanical, as well as chemical. The CRT used in your set is an electromechanical device which uses thermeonic emmission to generate a bunch of free electronics, which, being very light, do not fall to the bottom of the tube, but are controlled by the smallest of electrical or magnetic charges. The stream is attracted in the direction of the phosphor face by a high voltage electrostatic charge, connected by the ultor on the bell of the glass. There are other elements included to define the shape of the electrom stream, focus the mass into a pinpont, control its intensity and reduce the natural spreading which would take place since the like charged electrons would like to get away from each other. The deflection system used in early sets was electro-static. The voltage charge on deflector plates was used to control the beam, the same as modern oscillo-scopes. Later, when larger TV screens were desired, it was changed to a group of coils, would around the neck of the tube to form a magnetic field. The magnetic deflection system was also connected to either an electrostatic or electromagnetic focus system. But the item being controlled was the mechanical motion of the elctrons. From the very beginning, it was recognized that there were problems moving any solid matter. There is inertia of the matter itself, albeit very small for a single elctron, the mass required for a modern TV screen is large enough to be of thought in design of the scanning systems. There was also the transit time of the beam to be considered. It takes some finite amount of time to move the electron from the cathode to the surface of the tube where it strikes the phosphors. Oscilloscope manufacturers have long faced these problems in trying to make scopes which would display very fast events. There is also the impedance of the electron beam, mostly inductive in value to overcome, as well as some lesser evils. In short, there was a real problem in providing a system which would provide a stable image and designers of deflection systems incorporated all sorts of special adaptions to prevent ringing, non-linearity keystone, pincushion and other distortions produced in the mechanical scanning system.

Although it is now possible to have very fast response in the scanning system, due to technology developed long after the commercial exploitation of televison, the cost is currently not economically into the range necessary for consumer products. Thus, our present TV system is a step child of a mechanical system (indeed the first systems were ALL mechanical with scanning discs and neon or other light sources) and as such has developed a characteristic which is so inate that virtually no one can imagine a system nor even thinks about the mechanics of television. Enter the electronic digital age and solid state emitters.

The TV signal itself is very simple. It consists of three parts. The image is disceted in time by a scanning beam in the camera tube, converted into various analog electrical signals and transmitted. But what the camera"sees" is not apples, trees, people, cars and buildings. The camera is really a device to convert what we see as apples, trees, people, cars and buildings into an electronic representation which can be re-assembleed into a veiwed image, or reproduction. In otherwords, as you probably realize by now, when you watch TV, you are not watching trees, apples, people, etc, you are watching a reconstruction, a representation of these objects, an electronic picture.

What's the point? Just this, we have been tied, because of technology, to one certain way of developing and transmitting the pictures. However, there are other ways of developing the same images. It is up to us to develope these new ways and foster new developments in video technology.

THE NEW SYSTEM. All efforts in reducing the bandwidth necessary to provide for the transmission of a regular TV signal have been in one area- -reducing the amount of data, by deleting, or slowing down the data needed to reconstruct the image. The systems developed are simply adaptions of the mechanical scanning system. You can reduce the bandwidth by slowing down the scan rate, which slows down the data rate, but you are still sending every bit of detail in the picture, just more slowly. Thus you have lost some motion. THe second system uses a reduction in the number of picrure elements. Either by reducing the number of scan lines, the number of points per line or pixels, or a combination of both. Again, there is no change in the basic system used to develope the signal, it has simply been slowed down, or reduced by a data factor. In my system, there is a departure from this approach. It is not tied to a mechanical scanning system, nor is it any sort of Sampledot scheme in which psudorandom scanning is used to simple reproduce different areas at different times. The idea behind my system is to get to the basic core of the image itself. As the signal comes out of the camera, it consists of three basic parts, that is, it can be devided into three descrete components which can then form any image we desire. Since we have disceted the scene with a scanning beam, we have a TIME or INTERVAL component. There is also an amplitude or LUMINANCE component, and a color or HUE component. Now despite the NTSC system which uses a complex I and Q quadrature matrix, and subcarrier system, there is really only one value to color, which can be converted directly to phase. The saturation of that color is a function of LUMINACE. This is exactly what a VECTOR scope displays, So, be changing the HUE into a descrete phase angle (or so many degrees from a certain reference) we can describe any color, and in every TV station which transmitts color, that is exactly what is done. The simple second step, though has always been eliminated. While we have always transmitted the highly complex color signal, we have never transmited a simple signal that says, "THIS IS RED" or "THIS IS GREEN". In my system, this is what you do. In the process, you entirely eliminate the need for the referecne burst, since the receiver regenerates the "THIS IS RED" into red directly. The receiver knows that 45° sent as a digital word is the same as "THIS IS RED" and is the same as the complex IQ signal which is demodulated and matrixed to produced RED in your home TV. How simple! Likewise, for the luminance signal, THIS IS GRAY is sent vs an analog representation of the GRAY content developed from a ratio of the signal level used to denote black and white. So the three <u>real</u> basic components of the tv signal are INTERVAL, LUMINANCE AND HUE. Each of these can be seperated from the analog signal by relativly simple circuits and reduced to a digital signal. Now for a SECOND departure from current bandwidth reduction systems. In the medium scan and sample dot systems, there is an effort to describe, or transmit every bit of information in the picture, even if all the picture information is exactly the same. In my system, only one bit of information is required for each area of the picture. That is, it is not necessary to describe 256 points on a line of video to describe what the line of video represents. It is simply necessary to devide the line into TIME INERVALS, determined by the shape of the objects, and then describe the length of the interval, the luminance and hue during that interval. Thus if the entire line is RED, then it is necessary only to say that the entire line is red, not that 256 points on the line are

each RED. So now we have a real reduction in the amount of data required to send the same amount of picture detail. In this simple case, we had a reduction of 256 to 1. In the real world, it takes more than one DESCRIPTOR to define each line of video. But if we are going to use a line display system, (nothing says we have to) then we will describe the picture line by line.

From this simple beginning, plus the elimination of the sync system required by mechanical scanning systems, a great savings in bandwidth can be had with little sacrafice in video imagery. It becomes an electronic paint by number system in which brush strokes replace dots. The definition of the system is limited only by the number of DESCRIPTORS used to rebuild the line video information. In a basic and simple system, such as described in the the following article, only a small bit of information is used. If a more detailed picture is required, it is simply a matter of providing an increased library of descriptors. Whereas the library used in my basic system only has a few words to represent 64 shades of gray, 128 descrete hues and a limited series of 8 shading or sweep commands, it would be a simple matter to add more words to represent checkerboard patterns, maize, paisley, stripes, pokadots or any of various textures. The library of descriptors would be stored in your TV set which would use the stored information to reconstruct the picture using the incomming commands.

Also, in my simple system, because the original image was made from a mechanical scanning system, a regular TV camera, it was not necessary to provide an INTERVAL signal, simply a CONTOUR signal. The contour signal is developed from the luminance information and describes the edges, or the end of the intervals of similar color or luminace. Thus it represents a "real time" stop signal, and is used to simply tell the receiver"stop making the image described in the last command and start the new command here." A simple series of STOP commands. With digital sync replacing the analog and descretely timed sync pulses, it is also no longer necessary to have an end of line or beginning of line signal (which in analog TV is the blanking level). Instead, the data stream simple sends a NEW LINE word, and the scanning system simply starts the next line and starts using the next descriptor sent. A small savings, but a little is a little and it adds up.

The new system also envisions using a solid state display device, not a CRT, thus there is the total elimination of the need for a RETRACE or blanking interval required in electromechanical CRTs. There is also the elimination of the need for sync seperator circuits, RC time constants and real time time delay used to interlace the scanning beam on the 1980 model TV. There is simply no retrace time in a solid state desplay deyond that necessary to go from step to step in a column row counter, or at present technology, less than .001usec. With the introduction of one more element, the bubble memory (magnetic bubble) it is also possible to add infinite storage capacity to the image. Thus, by simple sending an indexing signal (step row step row, step row...) portions of the image could be sent once, and never sent again until changed. This did bring up the problem of the late viewer who turned his set on a fraction of a second after the image had been sent, and who is now receiving nothing by "next line" signals. The problem is solved by simply transmitting a complete image list as a refresher every once in a while, say every four seconds, or faster if necessary, or slower, it matters not how often, just once in a while.

Since the entire image is now in a very simple digital form, it can be sent in any manner you desire.

SECOND THOUGHTS.

By now you must realize that I am stark raving mad, crazy and ready for the rubber room. Well, let me carry the process one more step. If we ignore the camera used in developing the first image which was then converted into the simplified signal, we can imagine a solid state device which is outputted directly into an image processor. The processor would discover that there are circles, triangles, elipses, and other regular geometric shapes, plus a smattering of irregular shapes in the image. Our brains seem to work this way, since our eyes are simultanous transmitters and processors of images, and do not rely on any type of scanning system. The image processor would then convert the image into commands, such as, DISPLAY AN ELIPSE WITH A RATIO OF 1.3:1 in the area of coordinates 23,67. Or, display an elipse with a ratio of 1.35 with prime focus at 23.67 and a deflection of 25° negative. This would then be transmitted and the receiver would simply provide such an image. Far fetched? Nope. Computers are now just beginning to recognize shapes, but they are hindered by the SCANNING processes. If you had a simultanous parallel transmission system, the scanning is eliminated, and the block of information could be compared to stored libraries of images. The recognition speed would be increased, which at the moment is the only shortcomming of the modern computer image system, it cannot instantly recognize a shape, as we instantly recognize the various letters as an enire word. IE, we do not see and sort out: A M A T E U R T E L E V I S I O N as individual letters, compare them to a library of letter strings and finally recognize an exact duplicate in the library, light the "AH HA" light and say,"amateur television." We simply have learned to recognize that letter combination and instantly (in microseconds) recognize the words and the images or meanings we have attributed to those words.

Visions of Star Trek? (no pun intended) Maybe. But the system is realizable using current technology. It is more a matter of providing a better list of descriptors, and building the hardward to use such a system. But as long as CRT's and other components are cheap, the consumer TV will not be changed so radically in the near future. More ideas such as mini-tv stations, direct to home satellite, fiber optics and home information retrieval systems will be a more important part of every day life. As for the wired city concept (CABLE will take over the world and the free over the air broadcasters will be eliminated) bull feathers. Cable will no doubt hurt the ability of free broadcast to be able to produce the costly entertainment products presently offered, since they are the leeches of the industry, living off the fat of the free TV labors without contributing any substantial amount to the costs involved in producing the TV programs . The cable will never reach millions of people since the cable operators have no interest in building their expensive systems in the rural or wilderness areas. But thats another soap box for another time.

I do hope that someone will take the time and energy to develope a working system based upon my system or a variation.

Henry B. Ruh KB9FO

By the way, I am by no means a design engineer, having never been to engineering school, only fix it and make it work schools, so I expect some criticism and fault finding by my learned fellows, but the purpose of this enterprise is to foster new ideas and stimulate everyone's thinking. We tend to take TV for granted, those of us who grew up watching Milton Berle and Red Skelton, and our current system is not the only way we can generate and transmit pictures. Indeed, it should be one of our goals as amateurs to develope or invent new methods and techniques. This is but a suggestion(this article) that we are not confined by analog signals, 60 fields and 525 lines. TV is what WE make it. There are no limitations to our imagination except those which we artifically impose upon ourselves by not examining new avenues. This has been my tinkering toy for a few years, I hope it inspires others to find and try other methods. Fool or prophet, it mattera not what you think of my ideas, as long as it stimulates your energies to try something different. Please send your comments, legible coherent comments will be printed in later issues.

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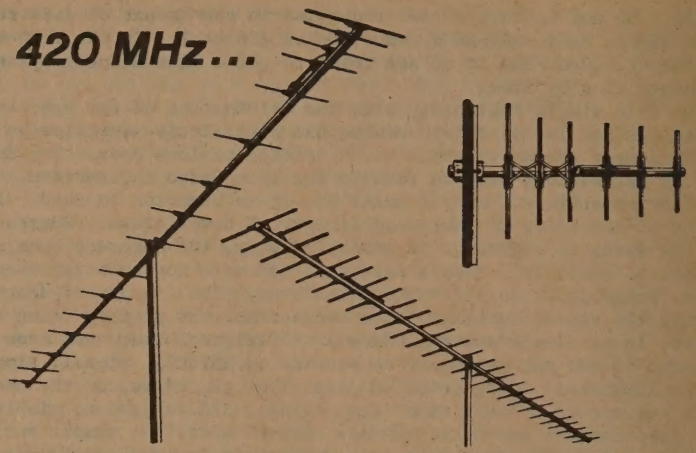

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This information, to the best of my knowledge is the first public expression of this system. While there may be such systems in existance or in labroatories, I do not have first hand knowledge of any such system, and as such I think that this is an entirely new and novel approach to the old problem. As such, since I do not have the funds to persue the idea furthur, I hereby grant the invention to the public domain where any interested individual may develope the concept into a viable working system. Henry B. Ruh KB9FO.

FREQUENCY DISCETED FAST SCAN TELEVISION

At last, a method of transmitting live pictures world wide on any frequency band available without a satellite.

The problem of sending live pictrures world wide, real live video has always been the problem of band-width vs the amount of information you were sending, IE, under typical conditions, with the normal fast scan TV signal, you would occupy four to ten Mhz with one channel of TV, and the interference to other services would be intolerable. However, there have been several methods tried including Don Miller W9NTP's medium scan system which allows real time moving pictures to be transmitted and reducing band-width by reducing the data either in frame rate reduction, scan line reduction or some system which incorporates parts of both systems. Now, here is an idea which works in the lab, and could possibly work in the real world. It was developed while working on a system which would make it possible to send more than one video signal on the same carrier wave. What it may allow is the first truly world wide fast scan TV signal.

Early experiments were in the field of video multiplexing. The plan was to reduce the redundant portions of a TV signal, so that a second, or more TV signals could be sent over the same TV channel. The systems developed were various schemes of time/frequency divison. By synchronizing two TV signals, it was possible to eliminate the second signals sync pulses. This provided a 1/6th savings in transmission time. IE, since there are 63 usec of time for one scan line, of which 11.4 u sec were devoted to sync information, if you could eliminate one entire sync signal, you could eliminate 11.4/63rds or about 1/6th of the time. This was easilly accomplished with a frame synchronizer. Since the sync was time coincident for both signals, it was a simple matter to simply insert the sync signal into both TV signals at the receive end. The second area of savings was to reduce the need for sync signals at all. This would save another 1/6 of the time needed to send two entire pictures. Instead of true sync signals, the sync was converted into two simple pulses (color requires three pulses). The pulses were 1 usec long for horizontal, and four usec long for vertical. This saved the 1100usec normally used for the vertical interval,or roughly 21/256ths of the scanning frame. This at first was a problem because the normal TV uses simple RC time constants to recover the sync pulses. The length of the pulses, Horizontal, Vertical and equalizing are such that the RC time constants are charged up to the value needed to determine which was which and run the oscillators in the set. In practice, it was a simple matter of detecting the leading edge of the sync to run a multi-vibrator which was AFCed onto the correct frequency by the pulses. The sampling circuit, if it detected a pulse longer than 1 usec, called it vertical. If the pulse was over 5usec, it called it noise and rejected it. Simple enough. Now we are dealing with a basically digital sync signal which no longer requires the long time constants the analog detectors required. The receive end was stil generating full time sync pulses for the output signal to the TV, but technology could easilly replace the "today's" TV sync circuits with digital detectors. There is still the need for the physical time interval to move the archeaic scanning system back and forth in the TV, but digital scanning of solid state display devices will end the need of an electro-mechanical electron beam scanning system. It was now a simple matter of inserting the second picture into the unused portions of the first TV signal in a time multiplexing scheme, and suddenly, it was possible, with a 2/3, 1/3 interlace system to send two TV signals over the same channel at the same time, and recover both with fidelity equal to the present one picture system. The first field is picture one, the second field is picture two, the third field is picture one, the fourth field is picture one, the fifth field is picture two and the sixth field repeats the pattern. The missing fields are sent in the sync intervals between the regular frames and betwen the regular lines. A complicated system, but a simple switch at the receive end, synchronized to the keying pulses seperated the images. The persistance of the screen as well as an electronic delay line or frame synchronizer did the rest. Simple.

This led to another discovery. With digital sync recovery, it was possible to send only the video portions, and use another frequency entirely for the sync, since it didn't matter how the signals were sent, only when. Thus, it was possible to send the 1 usec pulses on one frequency, using a very narrowband receiver, phase locked to the signal, and also send the four usec pulses over the same frequency. This could even be on phone lines since the repetition rate is 15,734Hz, which will pass over a broadcast grade phone line.

Next, it was possible to disect the TV signal into descrete frequency components. Nature does this nicely, since all picture information is normally sent in sideband energy which is multiples of the scanning frequency, or about every 15 Kc. By running the signal into a number of filters, it was possible to extract signal components for any particular sideband. Thus, it was possible to select a signal which was composed only of information at say, 2.8Mhz, 3.3Mhz, 4.2Mhz, etc. THis signal, when selected produced an edge effect. A contour was generated which represented the picture energy at the transitions of picture elements which co-incided object edges. By selectivly enhancing the original image to increase the sharpness of the edges, or transitions, it was found that most video signals could be contoured with a few sidebands clustered at 4.2Mhz. Thus, the shape of virtually every object could be defined by a single signal, constructed from information sliced out of the original scene at 4.2 Mhz. This is then, the "contour signal". The remaining information is simply level and hue and time span, how long at any particular level and hue. Much like a cartoon drawing is reduced to contour lines and painted in areas, it was now possible to disect a picture into contours, levels, hues and times. This reduces the number of elements to four. Descrete frequencies were utilized to transmit the information in digital form. Since the redundancy of the video is entirely removed, ie there is only one "word" to describe how much of the video line is at a particular level, the loger the area, the greater the savings in transmission time. IE, if the picture were solid red, with one black stripe down the middle, you would only send three words per line. You would send, the luminance level word, the time interval (say 20 usec), the hue (red) word, for the first half of the line, send the same three digital words to describe the black stripe, and agin the same words to describe the red area after the line. You have now reduced the image to nine digital words, which can be sent in less than 2 usec with ease. Meanwhile, you have described 63usec of image. A digital picture. Rather than sampling at a specific rate, and sending columns of repetitive information about adjacent pixels, you have simply described in the leasc number of digital words necessary, the video information represented by the line. Needless to say, the more detail in the picture the more information you must transmit, however, all redundancy is eliminated since you need not describe every pixel, only each group of pixels.

HOW MUCH DETAIL

How much detail you describe is going to define how much information you are going to send. There are three bits of information we are going to send, a start line or start field, which has been reduced to a single pulse, followed by a number of words describing each portion of the video line in terms of length, hue and saturation(luminance). By experimental means it was determined that 64 shades of gray would suffice for the luminance information, so 7 bits will signify luminence. The eye is much more sensitive to hue changes than to brightness changes. Since there are 360° of hue, you might think that it would take 360° descrete phases to reproduce the spectrum, but here we are able to reduce the amount significantly. First, the minimum hue change a sample of individuals were able to discern was 3°, with the most sensitive area being magenta which is a mixture of blue and red. Within the green, red or blue areas, perception was reduced. In red, the eye was most sensitive, being able to discern changes of 2° or less while in green, changes of as much as 6° could go unnoticed. So, a variable scale was devised which was weighted for changes in red, and less sensitive to changes in blue and least sensitive to changes in green. To blend adjacent areas, to avoid abrupt changes at contours, it was found that a simple memo which I'll call sweep, could be employed. The image is analyzed for phase change. The rate of change is determined for the period of time that the main hue is in the majority (from axis to axis using a three axis color triad). This was converted to a linear or non-linear sweep of the phase between two values. This proved easier than to limit the phase to descrete steps. Thus, a sloppy but sufficient color information word might say, sweep, during 21 pixels, from 165° to 180°. Since there

already was developed the weighted hue scale, the steps possible was reduced to 128. While you might think that since we still had descrete hue steps that the sweep method of phase shift might still produce an objectionable contour effect, the opposite was the case. Since the sweep could start at any descrete step, and go to any other descrete step, the actual viewed scene was an analog reproduction between the two points. The contouring or hue step is hidden in the image contour. This also reduces the number of descriptors required, since, again, a complete set of pixels can be described in one word rather than having to describe each pixel by hue. Where the sweep goes through a primary color axis, into another primary dominent area, two words are used, one to control the sweep of the first primary, the second to control the sweep of the second primary color.

In this manner, it is possible to produce a blend of any two primary colors in any porportion required. Since few if any natural colors require all three primary colors at once, (except white diluted colors, pastels) this is satisfactory. By subtractive color methods, the luminance signal provides the necessary third primary information automatically, reducing the need to ever send the third primary color information.

Now some of you may have been lost in that description. Let me provide an example. Magenta is really white minus green. If you turn down the green gun using the luminance signal, the remainder is magenta. By adjusting the level of red or blue, you can vary the remaining color from blue to red. By sweeping the color phase you accomplish the same hue change.

So we now have two of our three bits of information. The third element is time. The time interval can be selected in more than one way. We previously had developed an object contour signal, using the selected 4.2 Mhz information. This can be used to develope a stop signal at each contour line. In otherwords, the color/luminance information would be sent as two words, and the display device would produce that signal until it received a stop signel, denoting a contour, which would change the video to the next hue/luminance word snet. Very simple, but the contour signal might not be completely accurate for a soft focus object. The second way would be to count the pixels which are adjacnet to each other represented by the primary colors. This would produce three possible overlapping counts, and you would need to keep track of beginning points, which would increase the data load. The best method actually turned out to be a mixture of the two. First, the contour time interval, the time between adjacent contour lines developed from the 4.2 Mhz signal is counted. While that is going on, the color most dominant in that area between the pixels is counted, as is the second most dominant primary color in the same area. If the counts agree, ie if one primary color does not disapear during the area, then we need only one word to describe the time interval. If the primary color changes during the area, we are asked, how can an object change color but not luminance between primary colors? Evidently we have equally matched luminance levels, since there is no contour generated from the luminance channel, but the primary colors have changed. Once again, it is necessary to reproduce an analog change with a digital signal. At this point, we simply provide a keyed word which denotes the change point. It should co-incide with the time or pixel word used for the hue sweep control points, since this is a hue change between two primary colors, which we already discovered can be reproduced by a sweep between two hue radials. A simple comparison circuit verifies the co-incident point, and allows a fudge factor of 3 pixels since the threshold of the color detection circuit might be inaccurate on a very slow hue change. Many measurements were made and it was found that it was nearly 98% accurate to use the contour signal as the stop word, to describe the length of a hue display. The problems came in sunsets and similar images which are a severe blend of all colors which drove the circuits batty. Here, it was necessary to rely on the end of primary word. Integrating the two signals, contour and end of primary, produced an interleaved system which accurately described our time interval under all conditions. Since we were simply looking for a stop signal, or a way to measure the line segment length, there was no need to actually count pixels, and provicde descrete pixel counts.

At this point we have successfully described our video line in its simplest terms. It is now necessary to transmitt this data at a rate or in a way which will allow real time reconstruction at the receive end. We are already using a frame store receive unit, having abondoned the analog receiver in this system. The display can also serve as the image storage device. The use of a CRT is no longer necessary for a video display device. A full color image can be made from LED devices, arranged in the same manner as the phosphor dots on a regular CRT. The only concern at the moment is the cost of the blue LED's which are very expensive, but mass production could reduce this to the same level as the cost of red and green LEDs. A matrix of very small LED's could be arranged in any size, and electronically scanned, eliminating the time used to return an electron beam to the beginning side (blanking interval) Thus, overall definition could be increased. But, assume we are using the same scanning standards we are used to for the moment. We start with a blank screen, all LEDs off. We receive the first 4 usec pulse, and the sweep counters reset to row one number one. A microsecond later, we receive the first words, which describe the first picture element, not necessairly limited to a single pixel.

For the sake of illustration I will use a very simple scene. The word says, level 32 gray, sweep 165° to 180° time interval is 22. The circuits immediately light up the LEDs which correspond to this command, varying the intensity to comply with the command to sweep the hue from the two points during that interval. The LED's are latched on to this state by a hold circuit, and will stay in that condition until the next command is received for the area of the picture. Meanwhile, the next descriptors are received which describe the next area, and so forth. At the end of the line, the line pulse is sent, and immediately the scan is reset for the next line, etc. When the picture has been received, it will remain, frozen, untill new words are sent to change the picture. If there are no changes in several lines in the next frame, just the line pulse is sent, and the scanning system automatically skips the unchanged lines. If the scene is static, only the field pulse is sent and the scanning remains at the R1#1 position, waiting for a new command, during which time no additional information is sent. We have now reduced the transmission to only those lines which are volatile, and conserved perhaps 90% or more of the data transmission.

Now the question comes, what happens if you tune in on a static scene. Your receiver would not produce any picture at all since the only data being sent is the frame pulse which serves as a keep-alive signal to let your receiver know that a signal is indeed present. Simple. Once every 10th frame, a memory looks at what has been sent. If there has been no data sent for 10 frames, it recognizes it as a still frame picture, and simple refreshes everyone's set by transmitting all the data in the picture once. You do not see the transmission if you already have the picture, but if you are waiting for the picture, you had to wait 1/3 second before an image was started. Because of the data reduction, it will take about 1/3 second to provide a complete picture with the highest amount of detail possible. During normal video, the update rate is equal to that necessary in analog transmissions to provide a moving image.

The additional savings though have been in bandwidth. We have selected one descrete frequency for the sync pulses, to start the frames and lines, and a second frequency for the contour interval signal, and one frequency for the hue/luminance words. Each signal can fit into a 30Khz wide slot, reducing the total occupied bandwidth to 4 x 30 or 120 Khz and have not sacraficed any viewed resolution. We have essentially painted the color cells of an electronic cartoon cell with broad brush strokes, and electronically enhanced the picture with a swept hue command and image contours from the luminance signal.

Since there is no mechanical scanning, you are not limited to any particular scan format. The electronic scanning could operate at 1000 lines, 4000 lines or any amount you desire. Likewise, the field rate would be reduced (or bandwidth increased) for the higher definition signals.

With various multiplexing schemes available, it would be possible to combine one or more of the signal components to furthur reduce spectrum space. We have not violated the laws of data rate vs spectrum, we have simply reduced the data necessary to the bare minimums to describe, rather than display the total image. We have said that "this area is red, the next area is green, the next area is blue, without having to send that data for each and every point in the original picture. Its an electronic paint by number set.

Some explanation is necessary to show how the sweep command is used. Since the video in analog form is a continous variance of hue and luminance, it is necessary, in order to prevent contouring, to be able to preserve the analog form when reproduced. In actual use, if you have a CRT type display, this is simply accomplished by varying the Z axis, or the acceleration of the electron beam. In digital video, you will always have descrete steps. If you use a solid state display, each display set or pixel will be at a descrete level. This is also true in a color CRT since the phosphors are not continous, but in dots or lines which divides the analog signal into small but descrete points on the line.

The digital signal developes this in the transmit end as well as in the receive end. To reduce the effect of edging at the steps, it is possible to synthise intermediate levels between the descrete steps by sweeping the value in the receiver between the two points in the descrete image. If every object televised were to have a flat luminance and hue contour, it would become very cartoon like in appearance. To add realism and "life" or dimension to the reproduced picture, there had to be a way to vary the digital signal. In doing so, it was also possible to eliminate all the intermediate steps information which would normally be used to describe each small step if a complete digital picture were to be sent. Thus, instead of sending a bit stream which went from 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27...to what ever value was the end value, say 39 on the 64 steep luminance scale, it is simply necessary to say, sweep from 17 to 39. Or, S17,39. The rate of change is now necessary, since we need to know how much of the line is involved in the sweep, it could be a very rapid change, involving only 5 or 10 pixels, or it could involve the entire line of 256 pixels. So, a third word is added which tells the sweep generator how fast to do the change, now we send, S17,19,22. To prevent the problem of all variances being linear or logrithmitic (log for intensity and linear in hue shift) we can add still another value which will provide the contour data or gamma. For most purposes it is only necessary to describe the contour as being between linear and hyperbolic. Since these are the two possible extremes which will provide any contour necessary except a flat unchanged area, which requires no ~~contour~~ sweep information, and an object contour, which already is defined by the contour signal. So a series of more rapidly changing contours, or a family of curves is described by a value of 1-8. This same value is used to describe either luminance or hue shift rate of change. So the final descriptor for the area would be, S17,19,22,6. Which means, sweep the luminance from value 17 to value 19 during 22 timing intervals, using curve 6. This would on display be a very slight change such as a light shadow, spread over nearly a 10th of a line, with a very sharp change at the end of the line. In otherwords, a very gradule change for most ofthe area, followed by a rapidly changing value near the end. Since the value points are only a spread of three (17, 18, 19) the visual image would be a very smooth darkening of the picture with really little absolute change. Likewise, a rapid change, such as the shadow of a baseball might be described as S10,50,5,8. This would be a very radical change from bright to dark in a very short period of time with a very sharp knee. If the other side of the object went from dark to light, it would read S50,10,5,8 which would describe the reciprical.

Value"change scale"

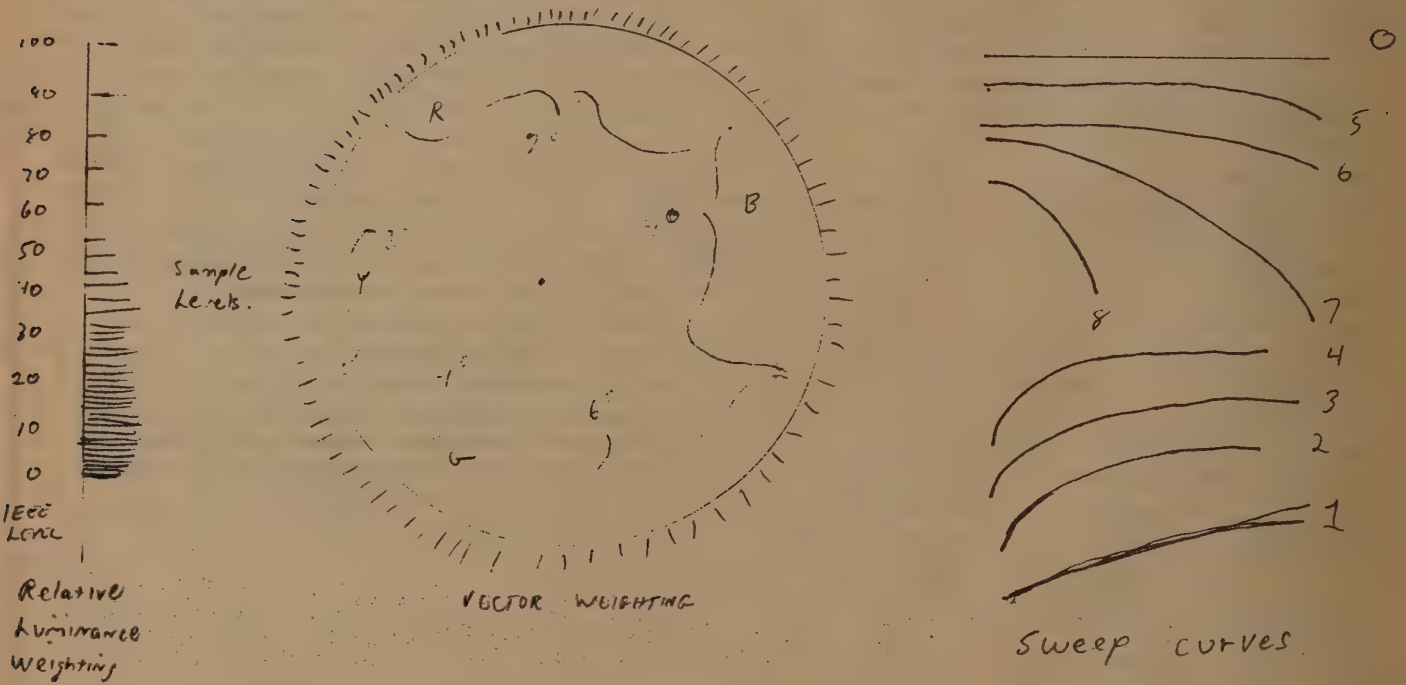
HUE	LUMINANCE	RATE	SWEEP?	TIME
0-128	0-64	1-8 (0 is flat)	S	2-256 (1 is a contour line)

The information is sent in a predetermined order, so no keys are needed to seperate the values. In actual use, the hue value would be reduced to 64 possible starting spots, and the sweep used to fill in any changes. With a little manipulation, the amount of bits needed can be reduced to about half the amount needed to send each item. For the sake of simplicity, the line has been divided into 256 pixels or time units. Since the time unit need not be sent if the time unit coincides with a contour limit, this information is seldom used except inconjunction with the sweep command. If the sweep is less than a contour interval, the time unit is sent, if the sweep is the same as the contour interval, it is not sent.

Since the aspect ratio, number of scan lines and overall definition can be defined in the receiver as well as the transmitter, it is no longer necessary to be satisfied with 60/15,734 or any other "standard."

The use of magnetic bubble memory would allow the home receiver to be built inexpensively, with a powerful microprocessor sorting out the information. The entire data stream could be sent over one frequency, or several frequencies could be used to provide a faster data rate. The use of the one and four microsecond sync pulses is simply to avoid display confusion caused by noise in the signal path. The sync pulses simple keep the picture aligned properly, but do not actually control the scanning process, which is digitally controlled from an accurate clock in the receiver. The frame store allows the input signal to be dissociated from the actual display scanning and also allows the picture elements to be saved from field to field. The solid state display devices would eliminate the need for interlace scanning since there is no flicker problem when the CRT is eliminated. The overall definition is determined by the time intervals, and the frequency used to develope the contour detail signal. It is possible to have more than one contour signal derived from the original video, to encompase soft as well as sharp contours to improve the "painting" of the image.

The final product is a reproduction, and not a direct representation of the actual video and will differ in some small degree.



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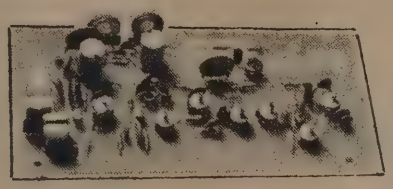

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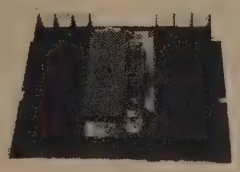

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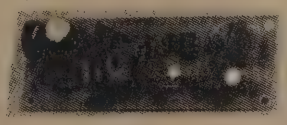

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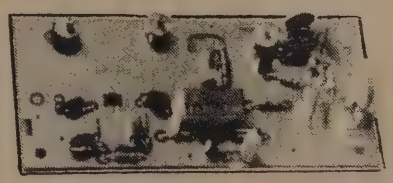

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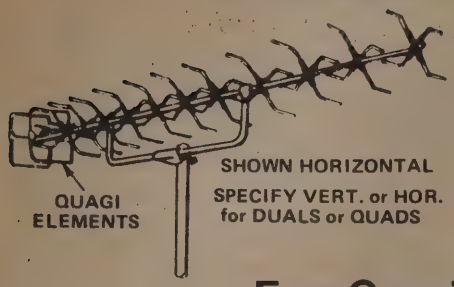

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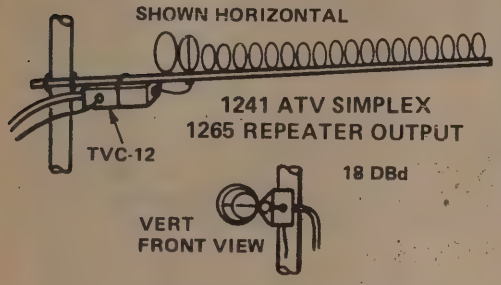

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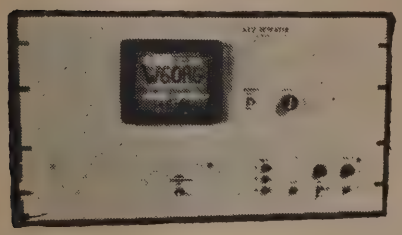

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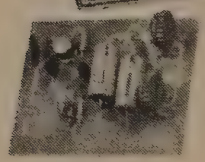

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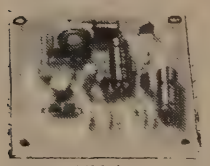
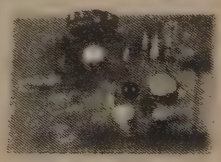


VM-4



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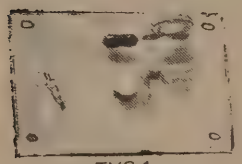

TVG-1

TVG-12

TVG-1 and TVG-12 ATV TEST GENERATORS . . . . . $15 ppd ea.

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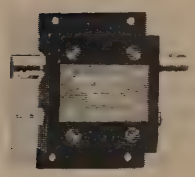

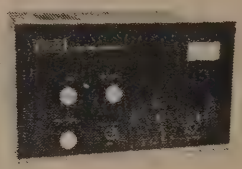

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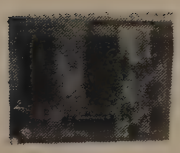

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VA-2 VIDEO DISTRIBUTION AMP . . . . . $18 ppd

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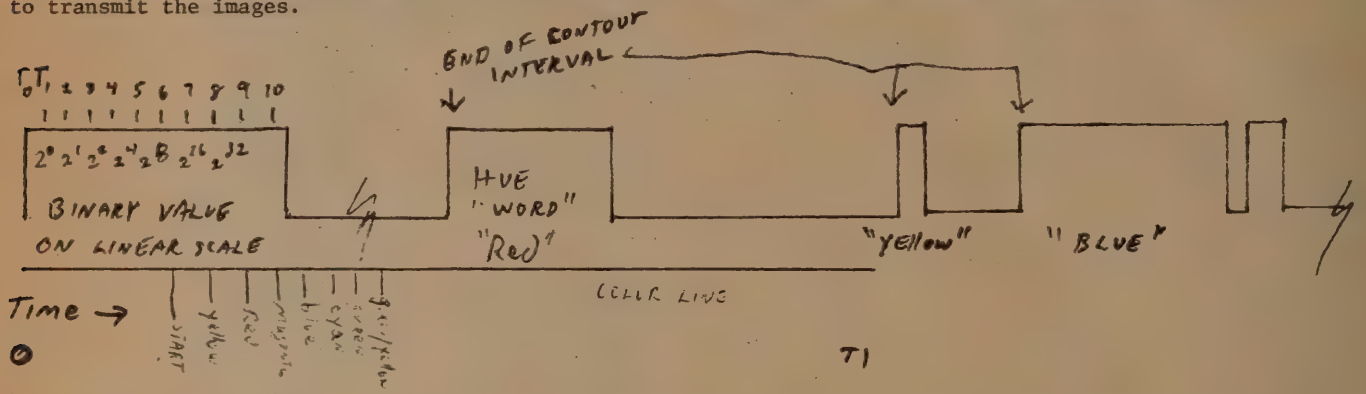
ADJUNCTIVE TECHNOLOGY

By now, I suppose the casual reader has gone on to lighter fare. But I would like to touch on a point not yet discussed which is a reduction in the data from a digital word, made of many bits, into an even simpler form. As you probably know, computers live in a binary world. We do not. And our digital signals do not require a binary system either. It is only illogical to think that a digital signal can only be composed of zeros and ones. It can be composed of any number of elements. For most digital video systems, the simple binary system is used, simply because of its on-off technology is easy to build, operate and understand. But it is hopelessly unwieldly in handling large numbers. And when combined with a high definition system, with the necessity to describe very small details you wind up with a system which uses up to 7 times the amount of spectrum needed to provide the same data in analog form. Why? Because it takes some power of two to represent the various steps betwen the two points used as the limits of your variable. IE, if you have only black and white, you only need two data states, or a power of 2 to the 1. If you want four shades of luminance, you require 2 bits, or 2 to the 2, etc. By the time you have 8 bits to represent 64 steps, you have just about defeated your purpose in terms of efficiency. What to do? Well, lets return to the HUE component of our visual signal. In regular TV, the hue component is constructed in a matrix using a complex system which we call NTSC color, which utilizes two subcarriers, seperated by 90° of phase in a quadrature modulation scheme. It was very clever when designed and still works today. However, to observe the three axis color signal, it is necessary to reproduce the signal on an oscilloscope. This tends to reduce our display to two axis since the Z axis is not of much use in this signal analysis. Instead, we observe the color as phase and distance. Phase from a reference, we call it reference burst, and distance, the distance from the center of the display to the point radially removed which represents saturation. Now, saturation can be represented in a different manner. It is, in one way, simply the dilution of a pure color (if you will allow that red, green and blue represent pure colors) by either black or white. Black and white are already defined as the luminance signal. And in most of your TV sets, and in the matrix systems used in the older four tube cameras, the colors were Y-r, Y-b, Y-g, or other mathmatical representations. Since we have already disected the luminance signal, and are only concerned with the color signal, lets play with the remaining property, phase, or hue. If you can imagine, taking the vector display, and bending it around so that you now have a linear scale, running from burst through red, blue, green, and back to yellow and endinging a hairline before the burst again, you will recognize that you can display the hue as a line of some length, or TIME. We have now made a simple conversion from radial to linear representation. Likewise, we need no longer refer to the hue in terms of degrees of seperation from the reference, but in TIME from the reference. Well, time is one of the three methods we have of transmitting our information. The three, to quickly review are, Amplitude, Phase and Time. Therefore, it is now a simple matter of calling the 0° point zero time, and placing some limit as to what determins the 359+° point in time. The limits we choose will depend on how accurately we can measure and define the interval and is limited only by our technology. Since you need to know if there actually is any data at 0°, we add a small offset interval, which we will call START, the length of which will always remain the same. If a pulse is shorter than START, it must be noise or an error. The result is that we have made a simple conversion to PULSE DURATION MODULATION or PDM. If the longest time interval needed to determine our linear scale is LESS than that required to provide the shortest object INTERVAL signal, we can interleave the two signals. We have now combined the CONTOUR and HUE signal into one simple on-off pulse sequence. The ON time represents the HUE information and the total time between the leading edges of adjacent pulses is the CONTOUR signal. As long as we obay the simple rules there can be no conflict between the two signals, since the linear hue scale is shorter than our erratic but also linear CONTOUR interval, provided the contour interval has a defined minimum value which exceeds the maximum value of the hue scale. At this point you could add an amplitude value which would represent the gray scale of the data word, but lets not mess up our simple two state system. Other timing schemes will produce the same effect, a key pulse could start each line, and the juxtaposition of the two signals could be varied as needed for reliability. At this point we have reduced a very complex digital signal to an extremely simple representation. If we were to use a non-linear or weighted decoding system, we could define certain amounts of pulse width to represent different values of change, and thus by "dropping out" intermediate values, reduce the length of the linear scale by some factor that we deceide upon. This simple makes it possible to increase the smallness of the contour interval. Only our technology limits us here gain, how accurate our clock and interval division.

Now, if we allow ourselves a third state for our signal, a step at say 50%, or some other definable value, we can add the luminance data concurrently. In other words, if our hue word is longer than our luminance word, we can change the amplitude of the hue signal, without affecting its length or value and insert our luminance data. In our earlier discussion, the luminace signal was digitized to only 64 descrete values, while the hue signal was digitized to 128, or twice as many. These numbers were experimentally derived, and aren't necessary if we convert the data to a pure analog form for PDM, since there is a finite but very large number of slices of time . But lets stick with the two numbers for now. We know we must have a start signal of some length in order to recognize that we have a valid signal. After that interval, we are free to adjust the signal as we please, as long as enough signal remains to prevent the decoder from saying that the signal has gone away, the interval ended, and now a value established. Thus, we can piggyback the luminace signal onto the hue signal, once again, provided that we have a maximum value for the luminace scale interval which is less than the smallest hue signal interval. This can be troublesome, since the hue signal could be a its 0 value, which leaves us with only the START impulse. If we lengthen START pulse, we must also loose our smaller CONTOUR value times. What to do? We must leave some time between the end of the HUE signal and the next START pulse to be able to recognize the next START pulse, so we cannot sandwitch the information after the HUE signal. If we use an amplitude change, we risk the possiblity that the change will be misinterpreted as a pulse edge. One solution might be to provide a simple FSK or FM of the carrier wave. The amount of shift can correspond to the luminance, VIOLA, we have just reinvented the principle of SSTV. By using the simple SSTV technique of having descrete frequencies

of frequency shift represent different gray scale values, we have added our third component and have been able to transmit all the pertinent data required to totally reconstruct the visual image.

I have purposefully omitted the mathmatics which describes the amount of bandwidth required in this type of system to produce any particular amount of data in the receiver. It is obvious that the more definition desired in such a system, the more bandwidth needed since the intervals will be shorter, and the sideband frequencies greater. However, depending of the image transmitted and the exact method and ratios of data reduction used following these techniques, it should be possible to reduce the bandwidth by a considerable amount, hopefully by at least 90% for all but the most highly complex visuals. I will leave it to the hardware mechanics, technicians and scientists of the world to define the standards for such a system which will then dictate the amount of bandwidth necessary to transmit the images.



DIGITAL VS PDM

As shown in the simple diagram, the HUE pulse length need not represent a linear function, of time equals phase. It can, instead, represent a digital, binary word, with each bit of time being equal to one binary level. Thus the 10 interval pulse at the start represents 2^9 plus the start interval which is equal to 2^0. The total time from leading edge to leading edge is the real time representation of the countour interval of the object. However, it also could be converted to the same time-binary value scale used for the hue scale, and each interval of time between pulses, or from the leading edge of the pulse to the next leading edge of a pulse could represent the contour interval on the same increasing scale. However, you would have to add a way to denote the zeros and ones for each value of 2, otherwise, you could not represent say 2^9 or 2^3 or 244, This could again be accomplished with FSK, by using "mark" as one and "space" as zero, to borrow some old teletype terms. It is much easier to simply give each finite point some predetermined value, based upon the linear scale or a weighted scale with unequal value changes still represented by linear descrete steps in the length of the pulse. Since part of our effort was to eliminate the need to send descrete binary values for each data word, this variation is discarded. It is here as food for thought. Simple PDM seems able to produce the data needed.

PDM DIRECT COLOR. Due to a quirk of nature, it is not necessary to convert a pulse length into a matrixed color. A spinning disc which is partially black and partially white, will, by varying the ratio and sequence of black and white areas, produce a visual effect of color. Samples of this anomily are often presented at science museums and small plastic wheel which you can attach to electric motors at home are available (Thanks to George VE3BBW for reminding me of this one). As th speed is varied or if the white area is interupted by a short black area, our eye is fooled into seeing colors which aren't actually in existance. This flicker TV coloring system should be a fascinating area for development. Since with a solid state display device, the flicker rate of each individual pixel could be controlled, such a system is possible. With the present CRT and electrical mechanical scanning, we are "stuck" with a 50 or 60 Hz flicker rate to begin with.

I would hope that this has been a novel and unique approach to the problem of bandwidth reduction of a video signal. It is my furthur admonition that it be given serious thought by those with the knowledge and means to replicate the system in working hardware so that everyone may eventually benefit from my efforts. Henry B. Ruh KB9FO Publisher, crack-pot and ATVer.

"If I have accomplished anything, it is because I have stood on the sholders of giants who proceeded me."
Newton.

As with any "new idea" there is always a basis in previous efforts. While the proceeding thoughts and ideas are as original as my brain can concieve, it is certainly based upon principles evolved in many areas by others much more brilliant than I. Needless to say the inspiration for inventing such a proposal has come from other amateur television experimenters whom I have met over the years. This product is dedicated to those who have provided the cumulative inspiration and knowledge that was required.

IN THE LAB WITH THE NEW TV SYSTEM

What do the pictures look like. What problems were encountered? What aspects worked? These are the questions that persons desireing to explore furthur the new TV system devised by KB9FO will ask themselves, so here are some of the answers.

First, the system in the lab used a simply LED display, and was simply to explore the question of could it work. The system was composed of a simply camera, a contour generating circuit swiped from a commercial camera, a video enhancing circuit used to emphasize the contour transitions, and a large RAM memory. Each LEd was driven from a specific memory address in a simple matrix read system. The LED was controlled by a sample and hold circuit which would maintain a specific current which corresponded to the data value for that LED. The data for CONTOUR and data for LUMINANCE was used. The HUE data was not generated since it was not a color system. Since the data needed to derive either the HUE or LUMINACE signal can be defined by either the pulse length or the frequency shift, the two values are technically interchangenable. A zero crossing pulse counter was used to count the carrier cycles, with five cycles of carrier being called START and each cycle after START given a specific value between black and white. A total of 150 cycles of time was called NEW LINE. Values from 6 to 134 cycles constituted 128 descrete "steps" and a simple divide by 2 circuit was used to COUNT GRAY LEVELS. Since over the air tests were not made, noise immunity could not be checked.

The pictures rendered were at first somewhat difficult to see as a whole because of the size and physical irregularity of the LED display matrix. This was solved by simple moving the LED array 8 feet away, so that the "artifacts" of the provess were not visable. An array of 128 by 128 LED was used as that was the largest array affordable.

Pictures sent were given to a cartoon like appesrance due to two visual factors which should disapear when a state of the art solid state display is developed. First, with the limited size of the array, some detail is necessairly lost, and often, a contour would disapear since it fell in time between two LED positions. This was solved by a reduction of the displayed elements produced by the system. If a complete array of 512 by 512 were produced this would not occur. No problems were encountered in the sample and hold circuits and the experimental set up would hold a picture without appearance of deterioration.

Analysis of the line display on an oscilloscope, of the derived signal, showed an average of 16 to 20 transitions per line. There were normally more on the central lines and less at the top and bottom of the image as was to be expected. Movement was somewhat earie since without texture, there is no sense of the background moving simple the contours move across the screen, which promoted the idea of instant cartoons. Since the objects had been reduced to FLAT representations. This also proved to be difficult since objects which lacked sharp contours suddenly would lose or gain "corners" or edges. Furthur refinement of the contour generating system is needed to counter this effect. The addition of the SWEEP signal helped in this regard since the sweep signal would visually replace the COUNTOUR signal on smooth shiny objects (such as a car as seen from a corner view). Motion was easilly observable with no noticable lag or stepping which slow frame rates produce. Since the system used 150 cycles to generate a complete descriptor, the carrier frequency used affects the maximum data rate. A high carrier frequency can produce a faster data rate. The bench test used a 27 Mhz carrier from a scrapped CB set and this proved adaquate. A spectrum analyzer was not available so occupied bandwidth was not observable (such are the fortunes of amateur investigation). The memory was too slow to accept the fast scan data directly (to generate the pulse length control) and a 16 port parallel input was used to jam the info in quick enough for analysis (determine gray level, control pulse length and generate contour time length. Noe being a computer freak this was the most difficult area for me. Des it work? Sort of. It still has some refinement necessary. Most of the problems encountered were in the generation of an accurate transmission system. The length of the pulse is so critical that this may be the systems drawback in real application. A problem developed in the delay time used when generating the pulse length control vs the real time contour signal. The contour signal must be delayed to wait for the pulse length signal. If adaquate meory were available this could be overcc

FUTURE VIDEO

If you read my earlier article on a futuristic video system, I will not call it TV since it is video and not necessairly television, I refered to a receiver, not a TV set. To explain, I'll let you in to see my crystal ball.

PREDICTIONS OF FUTURE COMMUNICATIONS

First, our present TV broadcast system is rather antiquanted in its approach to providing a TV image. The mechanical-electrical scanning system is already being replaced with electronic scanning of arrays of light sensitive elements, known as a CCD, or charge coupled device. This is a moasic silicon chip, an LSI device. It was first used in monochrome, and is now being offered in color cameras. The technology exists for a companion display device, using LED's or other light emitting substances. With this advance, there is no longer any need for the time intervals used in analog video display known as the blanking interval. In electronic scanning, the next bit is simply the next bit, and it doesn't matter if the bit is the beginning of the next line or simply one point on one line. Thus, you can have a 1/6th increase in definition or horizontal and vertical picture elements. Conversly, you can now use the blanking intervals for anything else you like. The electronic scanning system does not require different length pulses, to charge different RC networks to produce the horizontal and vertical scan signals, nor the wierd little equalizing pulses used to interlace the scan to reduce flicker. A single digital word can tell the receiver what line it is sending, and the rest is ABC. Since the sync signal need no longer be the most mighty portion of the video signal, the pulse itself can be eliminated. In fact all amplitude variations of th signal could be reduced to on-off or variable width pulses at a lower signal level, and still produce the same transmission range. Since TV is AM modulation, it is inherently inefficient since it is never able to produce an average signal level greater than 50% of the peak signal level except during a totally black picture. Thus by eliminating the amplitude variances, you culd use 50% power with no signal loss. Actually, a series of FM or PM signals would suffice just as well, and require much less power, saving millions of $$ in energy costs, and reducing spectrum clutter.

PREDICTION: Despite the inherent inertia of the Billions of $$ invested in the current TV system, it is possible for a second totally radically different TV system to be developed using the system described earlier, or other systems, which would provide more efficient spectrum use, lower power costs, and provide better quality pictures than NTSC, PAL or SECAM. Such a system will be available by the year 2000.

Direct to home satellite broadcats will be commonplace and the average set top unit, operating at 24 Ghz will cost $200 (1980 dollars).

There will be thousands of low power community TV stations providing information other than entertainment programming, ie a library of information.

Schooling at home via TV will replace transporting students to a common building. For homes where a parent cannot be in attendence to watch the child, central school type buildings will be provided with each student in his own video chamber, receiving lessons keyed to the childs individual progress and learning rate. A typical school day would last only 4 hours to cover the current crop of school subjects, rather than mandated 6-7 hours of class attendence, much taken up by "study periods, lunch, home room"and other time wasting unnecessary contrived items used to collect federal dollars to support obsolete school systems. Additional subjects of interest to the student would be available including fine arts, music, theatre, drama, politics currently not affordable in current classroom systems.

All students will learn how to operate and program computers by the 8th grade, with advanced school systems introducing computers as early as the 4th grade.

Network TV will become mainly an entertainment medium with news being available on your home receiver 24 hrs a day by topic, source, full length and summarized. Radio will remain basically unchanged except that new subsidary functions will provide SSTV pictures for home reception via AM-FM stations, radio for the deaf as it were.

Gasoline will be $10 per gallon and the average car will not use gasoline, those that do will get an average of 60 MPG. Alternate fuels will start to be common by the year 2000. Electric cars will be popular with lightweight rechargeable fuel cells.

A new broadcast band will be set aside for information services for direct to home transmission. You will pay for the signal as you do your phone bill. Henry KB9FO

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SSTV in Colour

First 2-way color SSTV transmissions across the Atlantic! Technical details on the equipment used at the European end of the path are included here.

By Jeremy Royle,* G3NOX

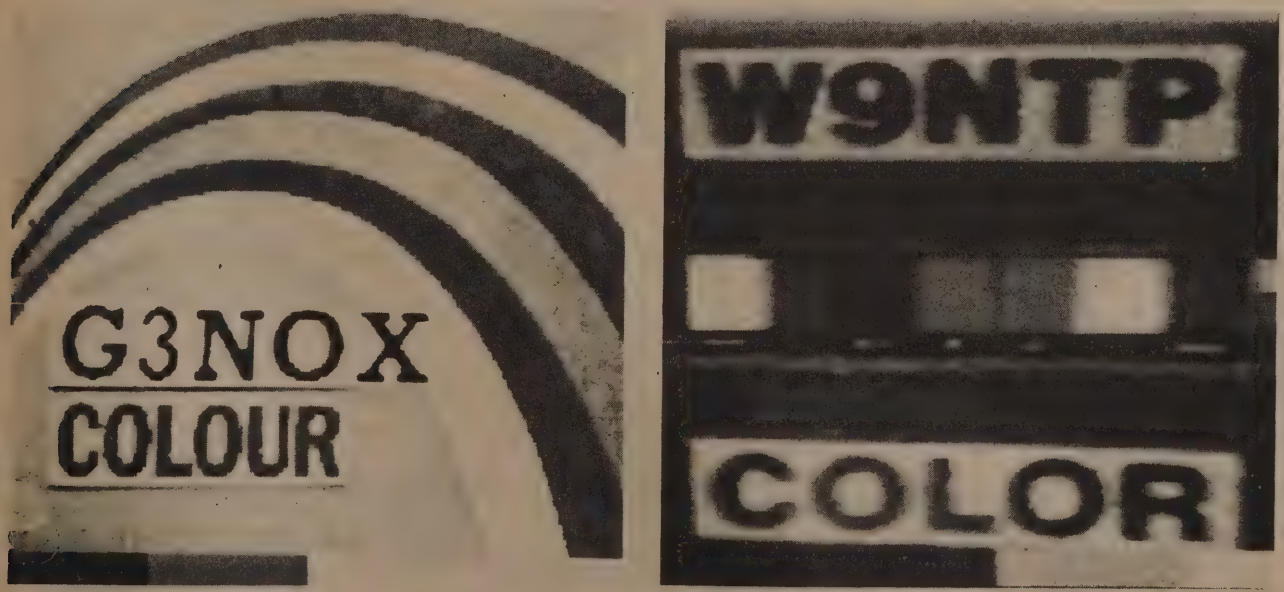
After many years of experimenting with fast-scan amateur television in the 436-MHz band, I visited the slow-scan station of Richard Thurlow, G3WW, to see his Robot 400 in operation on the hf bands. I was immediately impressed with the picture quality, in particular the bright fast-scan display of received and transmitted pictures. At the time, the technique of standards conversion was completely new to me.

I decided to buy a Robot 400 and to link it with my full-size image orthicon fast-scan television camera. The results in terms of picture quality were so good I immediately realized that by using the frame-storage system it would be possible to produce color pictures by sequentially loading two or more memory stores with color-separation signals.

The first stage in converting to color was to see whether my Pye 2014 image orthicon camera would produce the red, green and blue color-separation signals necessary for a full-color system using Wratten no. 47B, 58 and 25 filters. The results were good in terms of sensitivity and colorimetry, so I decided to remove the neutral-density filters from the supplementary filter turret (used in this camera for outside broadcast applications) and to install the Wratten filters on a permanent basis. A motor was also fitted so that the filters could be selected from the operating position.

To obtain the best signal-to-noise ratio with each of the red, green and blue (RGB) filters I use a Thorn Artificial Daylight fluorescent tube to illuminate the objects being televised. This type of tube, in conjunction with the filters used and the spectral response of the image orthicon tube, results in a near-perfect amplitude balance between the RGB color separation signals. Having produced the RGB signals from the camera, it is of course possible to load them one by one into a single Robot 400 and to transmit

*Keeper's Cottage, Duddenhoe End, Saffron Walden, Essex, England



On March 15, 1980, at 1430 UTC, Jeremy Royle, G3NOX, made the first transatlantic two-way SSTV contact with Don Miller, W9NTP, a pioneer of color SSTV. Signals consisted of electronically generated red-green-blue color separations from G3NOX, transmitted on 29.150 MHz using field-sequential emissions. W9NTP transmissions consisted of only two color separations, red and green. Shown here are the transmitted color picture as photographed directly from the monitor screen at G3NOX and the W9NTP picture as received.

The author uses a Thorn Artificial Daylight fluorescent tube to illuminate the objects being televised, not visible in this photo. The original rainbow test card is visible in front of the modified image orthicon camera, as is a BBC test card for use as a flesh-tone reference.

them in turn. However, in order to obtain a color-monitor display of incoming and outgoing pictures, it is necessary to be able to store all three colors simultaneously and to feed the outputs to a color monitor via an encoder. An alternative method is to feed separate RGB signals to a monitor having individual video inputs for each color.

At this stage I discussed the problem of synchronization with Martin Emmerson, G3OGD, who has built his own standards converter. He came up with a most elegant method of synchronizing the fast-scan clocks of the three Robot 400s. The method used is shown in Fig. 1.

Before carrying out the modifications to the Robot 400s, I gave considerable thought as to how the digital links could be made in such a way that things could be quickly returned to normal if necessary. The solution to this is to mount on the rear panel of the master 400 two DIN sockets, with a further one on each of the slave units. The result is neat and in my view does not detract in any way from the value of the 400! The internal connections can be made to the main Robot 400 circuit board via "header" plugs plugged in to the U48 and U10 sockets of each 400. These can be removed and the ICs plugged in again if it is desired to revert to normal. Any modifications can result in the warranty being affected and it is up to each Robot owner to make his own decision on this before carrying out the modifications!

It will be seen from Fig. 1 that one Robot 400 becomes in effect the master and through U48 controls the fast-scan synchronization of the remaining two units. For this reason it is not necessary for the crystal oscillators in the two slaves to function. In fact, to avoid possible beat patterns, I have removed the crystals in the two slave units.

In order to ensure black-level stability and constant color balance it is also necessary to install black-level clamps to the fast-scan video inputs of each Robot 400. This can be done by means of the circuit shown in Fig. 2. Existing pulses that are available on the Robot 400 board are used. Signals can be conveniently routed through spare pins on the main edge connector. The diodes and components can be mounted on the spare terminals of the board associated with the power supply. The black-level clamps make it possible to preset the "snatch" contrast and brightness controls, resulting in more consistent pictures in black and white, as well as being essential for color.

Monitoring

Having modified the Robot 400s as shown in the circuit diagrams, we come to the question of how to monitor the color picture produced by the synchronized Robot 400s. There are two approaches: (1) Use a standard color television set as a monitor, in which case it will be necessary to encode the RGB color signals and apply them to the color set via an rf modulator, or (2) use a professional RGB color monitor by feeding the output of each 400 as a separate signal to each input of the monitor.

Although the second method is expen-

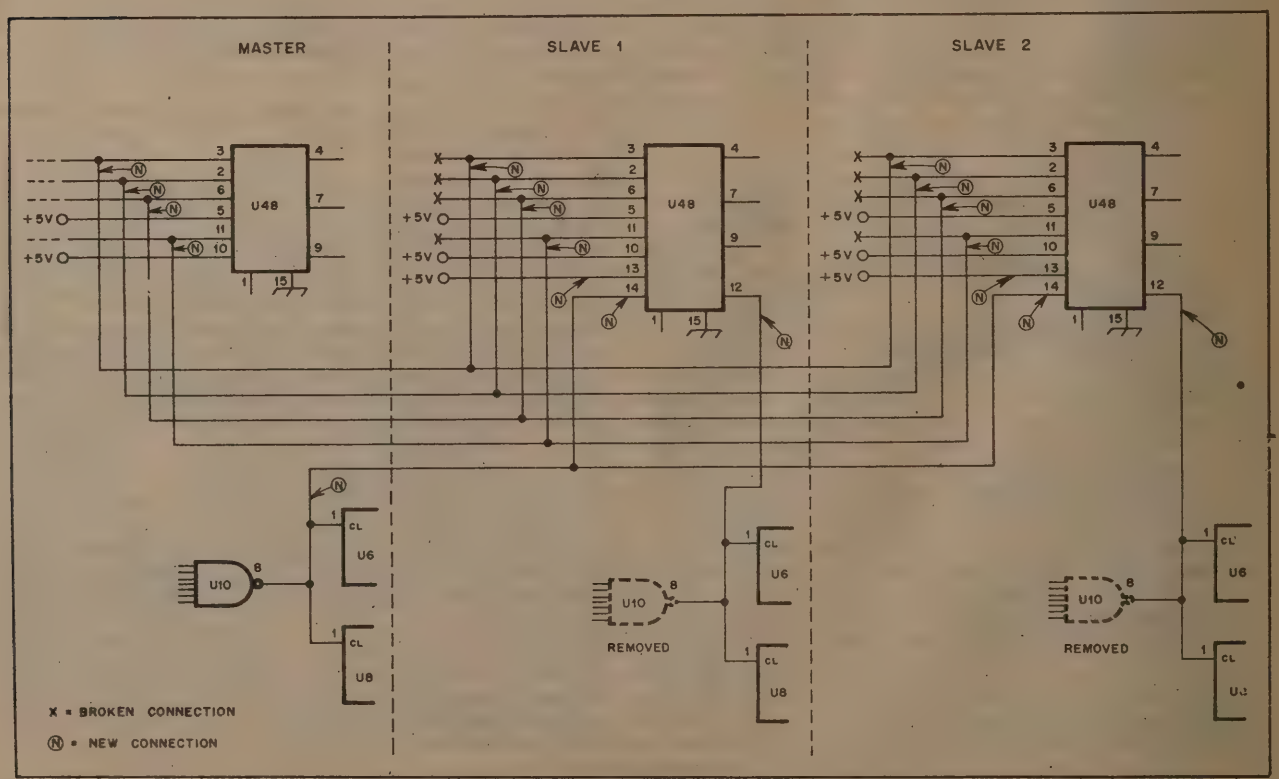


Fig. 1 — Circuit for synchronizing the fast-scan clocks of three Robot 400 scan converters. Two of the 400s thus became "slaves" to the "master." IC numbers are those of the manufacturer. See text regarding interconnections.

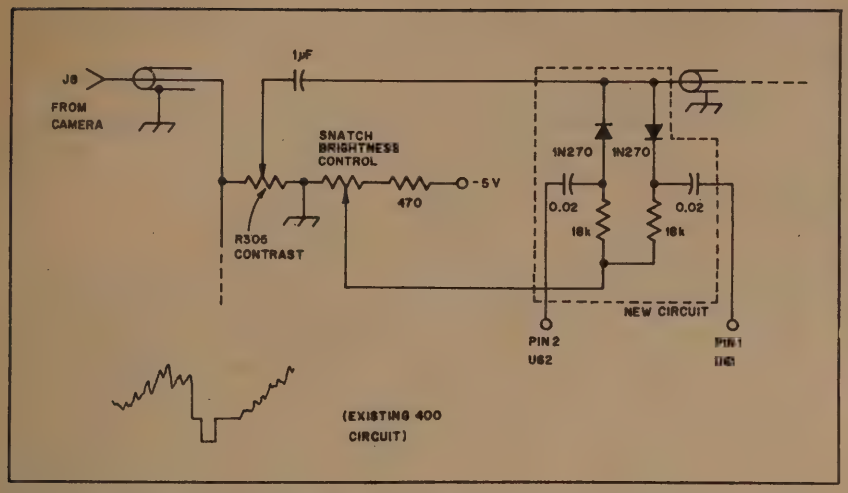
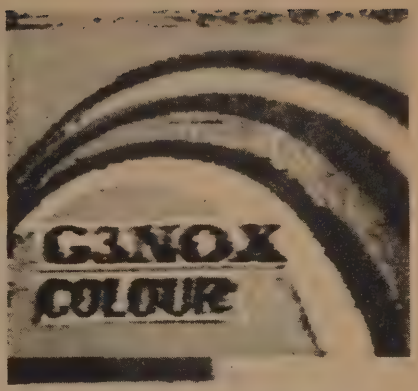


Fig. 2 — This circuit clamps the black level at the end of each scan line. Once they are adjusted, it is not necessary to readjust the controls. Only the camera iris need be set according to lighting conditions — a good procedure for black-and-white pictures, and essential for color!



G3NOX transmitted the first full-color SSTV signals on March 8, 1980, at 1145 UTC on 28.6 MHz. The color signal was received and tape recorded at K2RZ near New York, played back and received in color by G3NOX. The picture arrived at G3NOX with some interference, as shown here, after traveling a path distance of approximately 7000 miles.

The G3NOX color picture received at W9NTP on March 15, 1980. (*Photo courtesy of Don Miller, W9NTP*)

sive, the writer feels that this is really the best way, for it eliminates the problems of encoding and rf modulation, and gives the most accurate color.

Connecting the Complete System

To produce a color picture, the whole system is connected as shown in Fig. 3. The composite video and sync from the camera is fed to the video inputs of all three Robot 400s using BNC T connectors with a 75-ohm termination resistor on the last unit. Video outputs from the 400s are taken to the RGB monitor and to a 3-way switching unit which enables the black-and-white monitor to be switched to look at each of the three stored images — useful for normal black-and-white operation as well as for examining the RGB color separations.

The outputs from the transceiver, tape recorder, etc., are fed into the appropriate sockets on all three Robot 400s. In order to provide complete control of SSTV and microphone functions the three units are connected together as shown in Fig. 4. This also means that no extra switch boxes are needed to sequentially transmit the three color SSTV signals.

I have considered the possibility of making up a sequential switcher but experience with color SSTV on the hf bands has shown that at least two frames of each color are desirable to overcome QRM. This is most easily done with manual switching at both stations where human intervention can result in the best frames being held.

Setup and Color-Balancing Procedure — Transmission

Place the red filter on the camera. Adjust the iris, lighting and contrast control on the camera to give a good picture on a black-and-white monitor. If a scope is available, this should be connected to monitor the fast-scan video. This will assist in getting the correct video levels.

Next, cap the camera lens to give a black level. Switch all three Robots to the CAMERA DISPLAY position and turn all three snatch brightness controls fully counterclockwise. Set all the snatch contrast controls at the 3 o'clock position.

Now select the Robot gray-scale position on the memory-input switch and press all three snatch buttons. The color monitor should now display a neutral gray scale with no color tinting. If a color bias is apparent, the color monitor bias and gain controls should be carefully adjusted to give a completely neutral gray scale.

Select the CAMERA position on the memory switch and CAMERA on the display switch, leaving the lens capped. Adjust the snatch brightness on the red channel so that a red tint is *just not visible*. Repeat for the green and blue. The color monitor should now show a *black* level. If not, the color monitor brightness should be adjusted for the correct black level.

Uncap the lens on the camera and adjust the snatch contrast controls on each Robot to give a neutral gray picture consistent with correct contrast. Do not limit whites by setting the contrast too high. After this stage has been reached it is worth capping the lens again and repeating the preceding paragraph to ensure accurate black-level tracking.

Snatching a Color Picture

Switch to the memory display on all three Robots. Select the red filter on the camera and press the red snatch button. Repeat for green and blue and you should have a color picture. Because of lighting, camera spectral response and other factors it will probably be necessary to carry out fine adjustments of the snatch contrast controls *only* to get a true gray balance when using a gray scale in front of the camera.

I know this sounds complicated, but it is a once-and-for-all process, as the Robots are very stable. All you will have to do normally is to snatch a color picture and carry out fine adjustments. Make sure your lighting and camera exposure are correct by monitoring the camera video level on your scope against a graticule.

Setup and Color-Balancing Procedure — Reception

In order to receive accurate color pictures it is necessary to align the receive

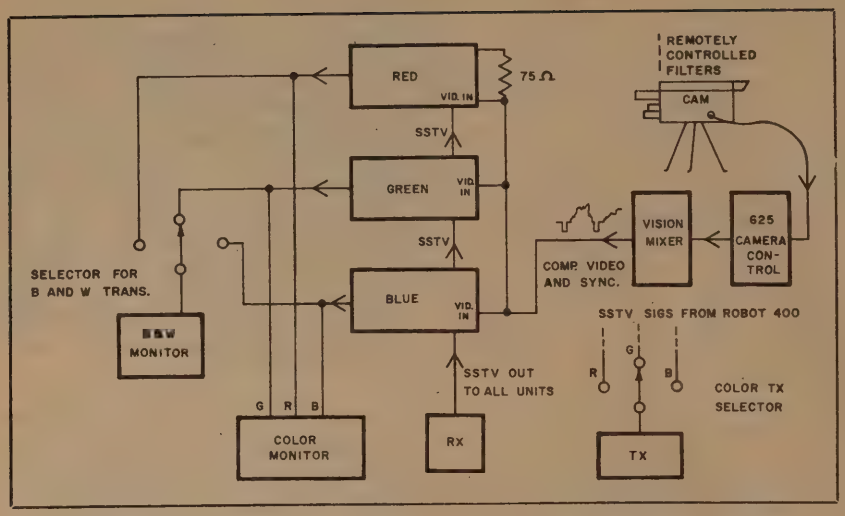


Fig. 3 — System interconnections for a complete color SSTV system using three Robot 400s.

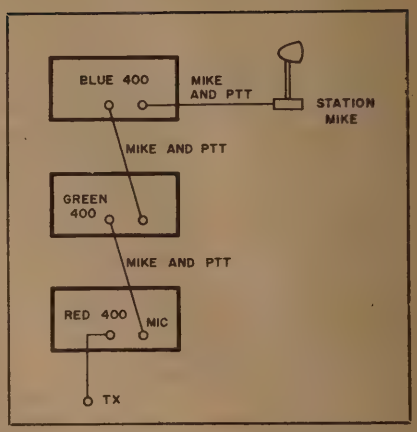


Fig. 4 — This system allows the switching of each Robot 400 to transmit in turn without making extra switching arrangements. Just use the normal Robot VOICE-VIDEO TRANSMIT switches on each unit.

brightness and receive contrast controls on each of the Robot 400s using the following procedure. Record about 5 minutes of gray scale from one of the Robot 400s after having previously checked the SSTV sync and black-and-white levels for the correct frequency, as laid down in the instruction manual.

Follow the procedure recommended for setting the receive brightness and contrast controls by comparing the taped gray scale with the local snatched gray scale. Repeat for each of the 400s. When this is done correctly, the *occasional* sampling error should be visible in the black and white ends of the scale. This indicates that no tones are being lost at either end by compression. Take your time with this setting as this is a once-and-for-all operation. *Do not* touch the receive contrast and brightness controls once this condition has been obtained.

Feed the tape-recorded gray scale into the red 400 and set the width control to just fill the screen. Adjust the width control on the green and blue 400s to obtain perfect registration of the gray scale on the color monitor.

To receive a color picture from another station switch all three Robot 400s to CONTINUE. Wait for the red frame to complete, switch to hold, wait for the green frame and switch to hold, and wait for blue frame and hold. If the transmitted signal was correct you should now have a color picture!

Operating Procedure

The standard color sequence of red, green and blue should be used for all transmissions and at least two frames of each color transmitted. This allows for a second chance at the receiving end if there is QRM or QSB. Caution: Color SSTV takes at least three times as long to transmit as black and white. Make sure you do not overheat your linear!

Avoid adjusting *any* of the controls on the 400 when using color. It is only necessary to adjust the video gain and lens aperture on the camera for correct levels.

The standard Robot Gray Scale will appear at the foot of all color pictures. This provides an excellent check on the overall alignment of the SSTV frequencies produced by the Robot 400s at the transmitting station. It also checks the correct adjustment of the receive contrast and brightness at the receiving station.

Providing that the incoming SSTV frequencies are correct, it should be possible to adjust your transceiver for "natural" speech and to receive the color SSTV picture without further adjustments. In any case the receiver tuning should not be altered during the reception of color frames or balance will be lost. If one of the color frames is lost because of QRM, it is possible to "repair" the picture by asking the sending station to send this color again.

The transmission of color SSTV is more complex than black and white. It is therefore necessary to reduce the number of operational controls to a minimum, and this has been achieved by treating all the Robot 400 controls as presets, using the procedures already detailed. On a well set-up system, all that is necessary is to set the camera iris, select the correct filter, and operate the snatch buttons.

Results

Some idea of the results that can be achieved with color SSTV are shown in the accompanying photos. However, it must be remembered that in these printed illustrations two *further* color-reproduction systems have been used — off-the-screen photography and the color printing process. The actual results on the monitor must be seen live to really appreciate the quality!

At the time of writing only about three stations in the world are known to be equipped for color SSTV. For this reason the writer has been sending color SSTV to stations equipped with audio tape recording and playback facilities connected to their transceivers and having them play back the color. The results have been very good, particularly when QRM and the Woodpecker[1] are absent!

Summary

The development of this field-sequential color SSTV system has involved some interesting problems of colorimetry, digital electronics and interfacing different types of equipment that were never intended for producing color pictures. Although this is a good example of the ham approach of using what is available to form a complete system, I appreciate that it is fairly costly — but then color in any medium usually is!

The thrill of seeing a full-color SSTV picture form on the monitor screen after its traveling many thousands of miles over a normal speech type circuit is a thrilling experience — certainly the most exciting thing the writer has done in Amateur Radio.

I would like to acknowledge the great assistance I have received on this project from Martin Emmerson, G3OQD, who developed the digital synchronization system and has given valuable advice to me.

[1]See "More Woodpecker Thoughts," *QST* Technical Correspondence, Jan. 1980.

CQ SSTV DE K4TWJ

DAVE INGRAM

Contributing Editor
Amateur Television Magazine

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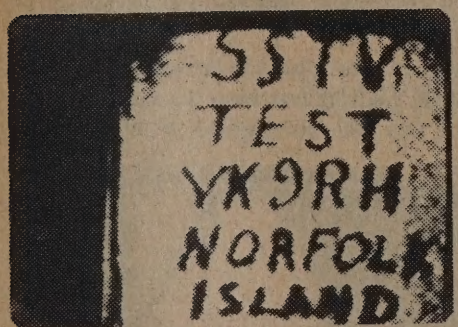
ON MEANINGFUL COMMUNICATIONS

I wonder how many SSTVers realize the full potential of our outstanding visual communications capabilities. Ours is an area capable of direct relations and idea exchanges which actually afford descriptions and sight transfers between various areas or lands. We can illustrate, for example, concepts and techniques previously unknown to distant amateurs and actually assist in ultimately improving their lifestyle. These illustrations are not limited to the world of amateur radio; indeed they may encompass a variety of subjects relative to health and welfare of distant people or their country. When you seriously consider that capability, the full power of SSTV communications becomes quite astounding. Our mode can also be used in a manner similar to a "new toy", entertaining ourselves in the same style as a new sports car, a new radio, etc. The choice of SSTV use, application and noteworthy acceptance, is thus directly in the hands of each and every active SSTVer. Please don't get me wrong or misinterpret what I'm trying to say. Every SSTV newcomer necessarily goes through an era of "proving the box works" and transmitting humorous sketches of everything imaginable. Heck—these pleasures are the prime reasons we are involved with amateur radio and SSTV! The world of amateur radio (and SSTV) can, however, be enjoyable and relaxing while also serving an extremely worthwhile service to mankind—and that truly results in a ten-fold enjoyment of our super-hobby. Since most of us are into this game for all the pleasure and gusto we can reap, why not make it a worthwhile venture with almost every operation and QSO serving a meaningful purpose.

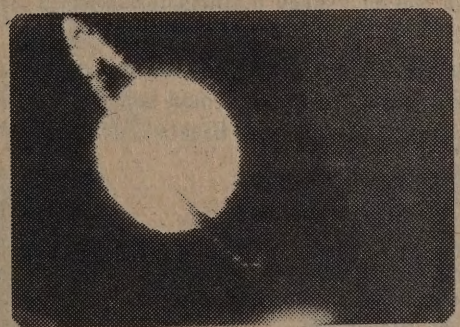
One example of such meaningful activity was the W6VIO (JPL club station) SSTV coverage of Voyager's flyby of Jupiter (this coverage will continue as Voyager passes Saturn). Amateurs throughout the world stayed glued to their monitors during that operation, relaying pictures to the media at a fantastic rate. "Ringside seats" were, indeed, quite enjoyable.

Another example of meaningful communications is the use which VR6TC often employs SSTV: gathering visual information for the people of Pitcairn. Tom can't perform this service alone; at least one person is required on each end of the QSO's. Again, this opportunity opens numerous doors for true applications of SSTV (W6IL is the man to contact stateside if you have an idea to assist the VR6TC works).

Remember the Mexican SSTVer who gave us those views of the Mexican pyramids and explained the Aztec calendar? Remember those views of the Alaskan waterways—the African Plains—the human eye operations? These examples of meaningful communications illustrate, in true form, how each of us has some particular aspect or knowledge which can be shared or used through the medium of SSTV. The applications for which SSTV is employed during our present times will have a direct influence on future evolutions, and possibly numerous world situations. We've proven our technical expertise, now let's each apply our visual asset to actions with truly meaningful purposes. The ultimate rewards can be timeless and extremely gratifying.



Another very special DX station joining the SSTV ranks is Ray, VK9RH. Ray also frequents 15 meters—and occasionally 28680 on 10 meters.



One of the first views of Saturn as transmitted on 20 meter SSTV by W6VIO at JPL in Pasadena. This view was more detailed on the SSTV monitor, but our anxious photography unfortunately was slightly defocused.

Detailed view of Saturn's ring with planet slightly above top center of this SSTV picture. Soon after this picture was acquired, additional views of ring spokes, metallic-type particles in the ring and views of two newly discovered moons were also relayed by W6VIO. Those pictures will be included next issue.

WATCH THAT DUTY CYCLE!

During a recent period of monitoring the evening's SSTV activity on 20 meters, I noticed more than one station transmitting extremely strong signals for alarming lengths of time. One particular station, which was running 30 db over 9 at my QTH, conducted a single SSTV transmission for a full 9.5 minutes before "coming up for air". I would be quite surprised if he had any final amplifier tubes left after that operation! Seriously, there are two considerations which all SSTVers should bear in mind at all times. One, the FCC requires each station identify itself at least every 10 minutes (in the case of SSTV, this identification should be mode on voice). "Pushing" this requirement doesn't help anyone's image (are you sure the other operator didn't fall asleep during that time), and can also create hard feelings among users of a busy band. Second, the 100 percent duty cycle plays havoc with many rigs and escalates the need for frequent "cool down" periods. Needless to say, RF power output should be decreased to at least half the station's normal output during SSTV transmissions. Additional RF power reductions are also highly desirable from both the standpoint of amplifier tube life and on-band QRM. Our present band conditions during this sunspot cycle are nothing less than great and high power really isn't necessary (as an example, we recently completed our QRP DXCC while running a mere 5 watts). If you really want to reap maximum enjoyment from your rig for many years time, use the amplifier but cut the driving signal until it actually "loafs along" at very low power. Then remember to keep your SSTV transmissions brief, and you'll still be "sitting pretty" during the coming low sunspot activity years.

DX VIEW

SSTV activity on the international scene continues to grow at an enthusiastic and encouraging rate. Our video listings are adding new countries each month, and SSTV DXing is truly becoming one of the hottest games on the bands. This month's prime DX news centers around FM7WW and YJ8IR. An interesting cargo consisting of a Venus SSTV system, Kenwood TS120 and two SSTV handbooks made its way to FM7WW during July, so watch for video activity from that area soon. Martinique is a luxury resort island known for its exotic clubs and nude beaches. Hmmmmm. The YJ8IR caper was pulled off during July by Mavis, VK3BIR. Although Mavis has now returned to Australia, we managed (I hope!) to arm her with enough SSTV enthusiasm for firm planting of "video seeds" in that remote area. Time will now tell the results of these efforts.

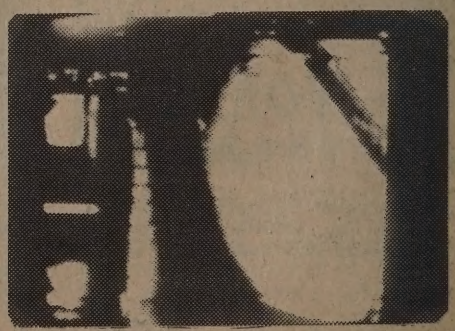
LATE BREAKING SSTV NEWS

Soon after this issue's column was set into print, a couple of very outstanding SSTV operations happened. Here's those details in a nutshell. Ben Golson, 4Z4JS, at Israel Radio, Box 1082, Jerusalem, Israel, was successful in his SSTV transmissions from that A.M. shortwave broadcast station during November 2 and 3. If you missed this first-ever event, here's the scoop (The notification came so quick we barely had time to pass the word!). Voice descriptions preceded each picture, which consisted of views in the city of Jerusalem. The 5 minute SSTV transmissions were featured every hour from that Sunday afternoon until late Sunday night. We copied the SSTV views very well here in Alabama on 7412 kHz, with SSB (zeroing the station's carrier) proving better results than the AM mode. Following the SSTV transmissions, Mr. Golson mentioned that future SSTV transmissions may be implemented. More details next issue, meanwhile, stay abreast of SSTV network news and W1AW bulletins in case another "surprise activity" takes place.

The JPL Club station, W6VIO, again took to the airwaves during early November, as Voyager I began its historic flyby of Saturn. The views of Saturn were absolutely incredible! Obviously, this was W6VIO's greatest operation to-date. A total of 26 operators manned W6VIO day and night during the period, and a direct video feed from Mission Control provided live views as they arrived from the spacecraft. A few of the many, many views relayed by W6VIO are included in this column. Additional pictures, plus a synopsis of the JPL operation will be included next issue (the flyby is still in progress as this information is being written!). Surely I speak for all Slow Scanners when I extend a million and one thanks to JPL for the fantastic views.

That "wraps up" the views for this time, gang. Remember to drop up a letter on your ideas and activities (along with a photo of you and your impressive SSTV shack) for the next issue of A5. 'Til then, we'll be watching for you on 14,230, 21,340 or 28,680. 73, Dave Ingram, K4TWJ, Eastwood Village #1201 South, Rt. 11, Box 499, Birmingham, AL 35210.

Looking for an exciting and meaningful SSTV QSO? Check the high end of 15 meters around 0000 6mt for VR6TC.



Another W6VIO-relayed view from Voyager as it moved closer to Saturn. Calibration and gray scale markers on right of picture are result of direct video feed from Mission Control to W6VIO.

ATV PREAMP

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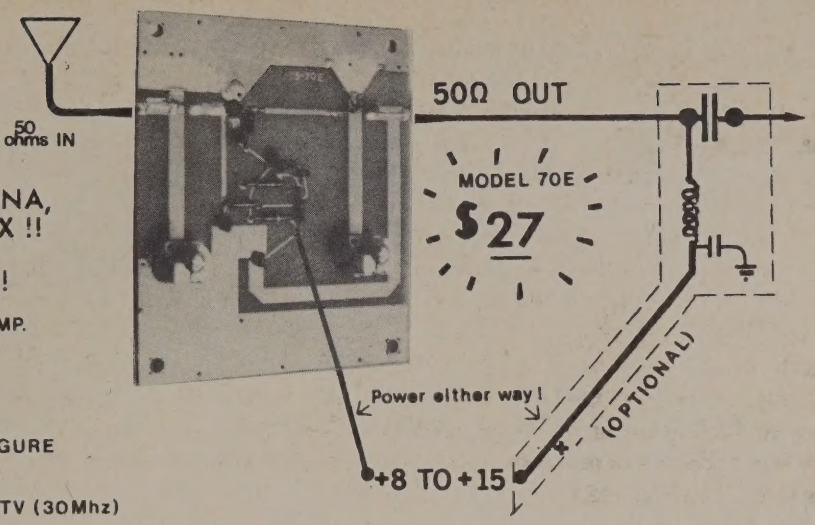

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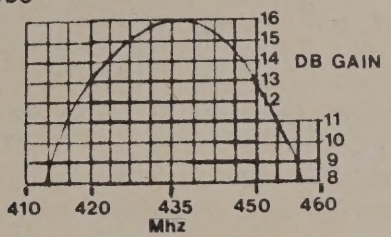

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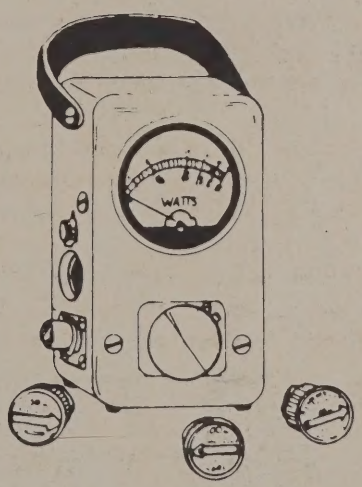

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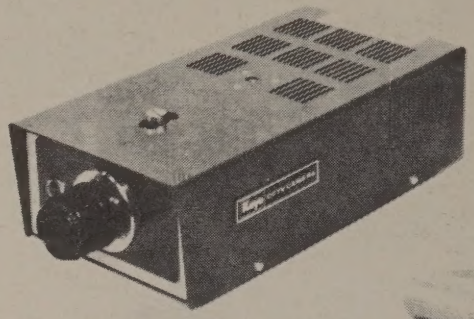

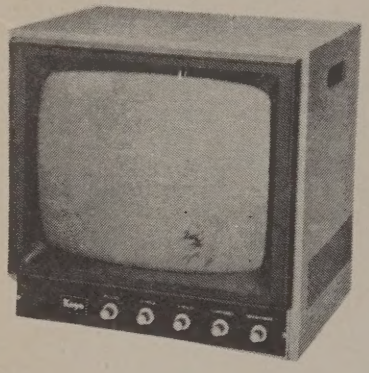

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